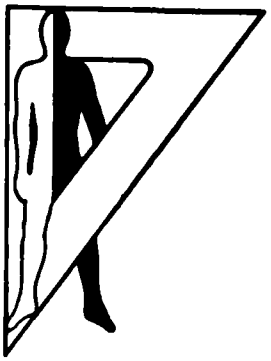

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Technical Note 2-82

HUMAN FACTORS EVALUATION OF THE COMBAT VEHICLE CREWMEMBER (CVC) SPALL PROTECTIVE FACE MASKS

Richard S. Bruno

January 1982

U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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This report is a human factors evaluation of the Combat Vehicle Crewmember Spall Protective Face Masks. The US Army Human Engineering Laboratory was tasked by the US Army Natick Research and Development Laboratories to conduct an evaluation of two prototype concept face masks. A third concept face mask was configured during the evaluation. Recommendations are described in detail.

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HUMAN FACTORS EVALUATION OF THE COMBAT VEHICLE CREWMEMBER (CVC) SPALL PROTECTIVE FACE MASKS

INTRODUCTION

In 1979 the Combat Vehicle Crewmember (CVC) Uniform was evaluated and then standardized, except for a few components of the uniform system. The CVC Spall Protective Face Mask was one of the components that was not standardized. The US Army Natick Research and Development Laboratories (NLABS) redesigned the CVC Face Mask. As a result of a meeting on 12 November 1980, NLABS tasked the US Army Human Engineering Laboratory (HEL) to conduct a human factors evaluation of two CVC face mask concepts.

The CVC Face Masks were designed to provide armored vehicle crewmen with facial protection against low-velocity fragments, flame, dust, and wind. It can be worn with or without the balaclava, with or without eyeglasses, and in cold or warm weather.

At the conclusion of test day 3, a meeting was held between HEL and NLABS personnel to discuss test continuation with the face mask concepts in the present configuration. An agreement was made to designate the testing of face mask Concepts 1 and 2 as Test Phase 1. Test Phase 2 consisted of the remaining test days to review face mask Concepts 2 and 3. Face mask Concept 3 was a modified Concept 1 face mask. The modification eliminated the two temple straps.

OBJECTIVE

The objective of this human factors evaluation was to compare and assess three cold weather face mask concepts for combat vehicle crewmembers. The face masks were evaluated for general compatibility in the operational environment.

METHOD AND PROCEDURE

Test Participants (TPs)

Eight tank crewmen, MOS 19E, from the Soldier Operator Maintainer Test Evaluation (SOMTE) Group, Field Support Branch, Materiel Test Directorate, Aberdeen Proving Ground, MD, served as (TPs) during this evaluation.

The anthropometry of the TPs is given in Table 1.

TABLE 1

Anthropometry Tankers

Measurement No.	Name	N	Mean	SE(M)	S.D.	SE(SD)	%	Min.	Max.
1	Weight (KG) K	8	76.03	4.39	12.41	3.10	16.3	60.3	96.9
2	Stature (cm)	8	172.26	2.52	7.14	1.78	4.1	159.3	181.4
16	Arm Length (cm)	8	76.34	1.60	4.54	1.13	5.9	68.8	83.9
29	Chest Circumference (cm)	8	94.75	2.65	7.49	1.87	7.9	84.3	110.4
33	Waist Circumference (cm)	8	81.80	3.80	10.74	2.68	13.1	71.4	105.1
56	Head Circumference (cm)	8	56.36	0.59	1.68	0.42	3.0	53.9	58.3
57	Head Length (cm)	8	19.46	0.14	0.41	0.10	2.1	18.9	20.0
58	Head Breadth (cm)	8	15.16	0.19	0.55	0.14	3.6	14.5	16.0
61	Face Breadth (cm)	8	13.65	0.24	0.69	0.17	5.1	12.6	14.9
63	Face Length (cm)	8	11.81	0.22	0.62	0.15	5.2	11.2	12.7
62	Bigonial Breadth (cm)	8	11.00	0.22	0.61	0.15	5.6	10.2	11.6
64	Nose Length (cm)	8	4.90	0.12	0.33	0.08	6.7	4.4	5.4
65	Menton-Stomion Ln. (cm)	8	4.95	0.15	0.43	0.11	8.7	4.3	5.6
66	Biocular Breadth (cm)	8	9.10	0.13	0.36	0.09	4.0	8.4	9.6
67	Interpupillary Breadth (cm)	8	6.55	0.13	0.37	0.09	5.7	5.9	7.1
	Age (Yrs)	8	23.63	1.69	4.78	1.19	20.2	20	34
	Time in Service (Mo.)	8	65.38	17.0	48.02	12.01	73.6	31	162

Clothing and Equipment

1. Clothing. The Standard "A" Cold Wet Uniform was used as the basic uniform. Clothing layers were adjusted according to weather conditions and activity levels.

2. Equipment.

a. Helmet DH-132 CVC
b. Balaclava CVC
c. Face Masks Prototype Concepts:

1. Concept 1 - single eye opening
2. Concept 2 - modified version of Concept 1
3. Concept 3 - Concept 1 with no over-the-head strap

A full description of these masks are given in the Fact Sheet, Appendix A. Figure 1 illustrates the three face mask concepts.

d. Goggles:

1. CVC (improved)
2. Modified, CVC W/Velcro Strip

e. Vehicles used:

1. M60A1 Tank (2)
2. M1 Tank (1) used only for mask/optical devices check

The basic design for Phase 1 of this evaluation is shown in Table 2 and is a repeated measures type with all TPs exposed to all mask conditions. Test runs were randomly assigned and counterbalanced for time of day and exposure sequence. Comparisons were made between the two (Concept 1 and 2) spall face masks.

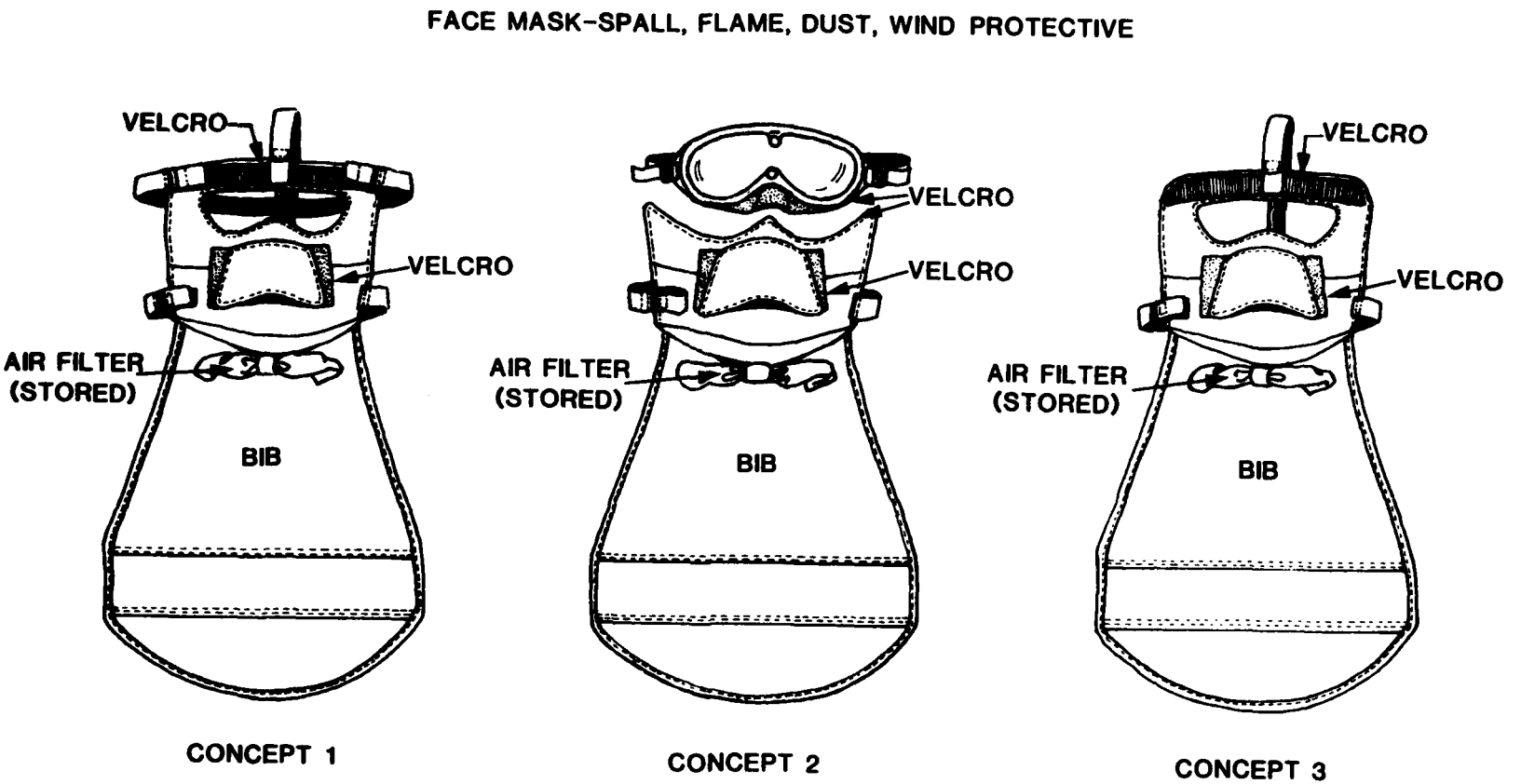


Figure 1. The three face mask concepts evaluated.

TABLE 2

CVC Face Mask Test Design

	Day 1		Day 2		Day 3		Day 4	
	G1	G2	G1	G2	G1	G2	G1	G2
AM								
Run 1	C1	C2	C2 w/B	C1 w/B	C2	C1	C1w/B	C2 w/B
Run 2	C2	C1	C1 w/B	C2 w/B	C1	C2	C2 w/B	C1
PM								
Run 1	C2 w/B	C1 w/B	C1	C2	C1 w/B	C2 w/B	C1	C2
Run 2	C1 w/B	C2 w/B	C2	C1	C2 w/B	C1 w/B	C2	C1

Two Tank Crews: Group 1-4, Group 2=4 TOTAL: 8 TPs
B = Balaclava
C1 = Concept 1 Spall Mask
C2 = Concept 2 Spall Mask

In each test cell the TPs were required to fulfill four MOS related scenarios and to maneuver the tank on a dirt tank trail, approximately 6km in length. The scenarios were Vehicle Fluids Check, Track Adjustment, Ammunition Reload and a Tactical Mine Sweep and are shown in Tables 3, 4, 5, and 6. The Tactical Mine Sweep Scenario was conducted on the tank trail.

TABLE 3

Vehicle Fluids Check Scenario

1. Loader exited his crew station and proceeded to rear deck of tank.
2. Loader opened the grille doors 1, 2, and 3. Fluid level check of oil and transmission was conducted. Fluids were added if necessary at that time. After the checks were made, the grilles were secured.
3. Loader returned to his crew station to continue the mission.

TABLE 4

Track Adjustment Scenario

1. Driver allowed tank to roll to a stop without using brake.
2. Loader dismounted tank to conduct an inspection of suspension system and track.
3. Driver also dismounted tank and proceeded to sponson box.
4. Driver opened sponson box and removed track adjustment bar and wrench. Necessary adjustments were made to track. Driver returned wrench and adjusting bar to sponson box.
5. After inspections and adjustments were made, the loader and driver remounted vehicle.

TABLE 5

Ammunition Reload Scenario

1. Driver stopped tank and exited crew station.
2. Driver postioned himself for ammunition reload from ground on tank.
3. Gunner exited hatch and proceeded to side of turret to accept rounds from driver.
4. Loader positioned himself to accept and place round in ammunition storage area.
5. Commander supervised reload operation.
6. Reload completed, crew mounted tank and continued mission.

TABLE 6

Tactical Mine Sweep Scenario

1. Commander alerted the crew to possible mines.
2. Driver stopped tank and allowed loader and gunner to dismount.
3. Commander scanned surrounding area from high vantage point.
4. Loader and gunner visually and physically reviewed area for potential mines. Located mines were marked and tank rerouted.
5. After mine fields were bypassed, the mission was continued.

The vehicles averaged 15 miles per hour with a maximum speed of 30 mph.

The purpose of the tank trail runs was to familiarize the TPs with the clothing ensembles while performing MOS-related tasks. The TPs and uniforms were subjected to such environmental elements as water, mud, ice, and cold temperatures.

After familiarization with the clothing ensembles, the TPs were able to make subjective evaluations and discuss body/clothing and vehicle interaction. A Modified Semantic Differential Rating Scale (MSDRS) was used to make subjective assessments and is shown in Appendix B.

The face masks were sized and fitted to the TPs by NLABS personnel. Donning instructions were also provided by NLABS and are presented in Appendix C. Results are described in the Fitting and Compatibility Assessment Section of this report.

Essential Characteristics Assessed

The following essential characteristics were assessed:

1. Donning and doffing.
2. Fit (static and dynamic).
3. Compatibility of the face mask with the DH-132 Helmet, improved CVC goggles, and balaclava.
4. Compatibility of the face masks with tank optics.

Data Collection Methods

The following data collection methods were used:

1. Observation.
2. Modified Semantic Differential Rating Scale (See page 35).
3. Debriefing.
4. Sizing and fitting.

The basic design for Phase 2 of the evaluation is shown in Table 7 and is a repeated measures type with all TPs exposed to all mask conditions. Test runs were randomly assigned and counterbalanced for time of day and exposure sequence. Comparisons were made between the two (Concept 2 and 3) Spall face masks. The four scenarios were also used during this phase of the evaluation.

TABLE 7

CVC Face Mask Test Design (Phase 2)

	Day 3		Day 4	
	G1	G2	G1	G2
AM				
Run 1	Balaclava only	Balaclava	C3 w/B	C2 w/B
Run 2	C3	C2 w/B	C2 w/B	C3
Run 3	C2	C3 w/B	Balaclava only	Balaclava only
PM				
Run 4	C2 w/B	C3	C2	C2 w/B
Run 5	C2 w/B	C2	C3	C2 w/B

Two tank crews: Group 1=4, Group 2=4 TOTAL: 8 TPs
B = Balaclava
C2 = Concept 2 Spall mask
C3 = Modified version Concept 2 Spall mask

DONNING, DOFFING, AND FIT OF THE FACE MASK CONCEPT

Objective

The objective of this phase of the evaluation was to examine donning and doffing methods and procedures, plus a review of face mask fit.

Method and Procedure

The TPs were given an introductory briefing on the face mask concept by HEL and NLABS personnel. Instructions on donning and doffing per face mask concept was conducted and provided by NLABS in Appendix C. NLABS personnel also conducted a fitting trial with all face mask concepts.

Results and Discussion

Fit (Static and Dynamic)

Table 8 gives the sizes of the face mask concepts by TP.

TABLE 8

Face Mask Concept Sizing Per TP

TP No.	Concept 1	Concept 2	Concept 3
1	M/L	M/L	M/L
2	S	S	S
3	M/L	M/L	M/L
4	S	S	S
5	M/L	M/L	M/L
6	S	S	S
7	S	S	S
8	S	S	S

M/L = medium large
S = small

In Face Mask Concepts 1 and 3, the material surrounding the eye opening was large enough not to hamper vision or impact on eye movement.

The area below the eye opening of all three face mask concepts were identical. The TPs verbally reported no major differences in regard to fit.

The nose cover was very adjustable through the use of Velcro. No major negative nose/mask interaction was verbally reported by the TPs. The Velcro nose adjustment allowed proper positioning of the DH-132 CVC Helmet microphone.

The enlarged chin area did not impede movement of the jaw while talking. However, the TPs verbally reported that the spoken word was slightly muffled when talking face-to-face.

The head harness buckle allowed the smooth elastic strapping to slide and lose the initial adjustment.

The dust cover was never used during this evaluation.

Donning and Doffing

Concept 1 Face Mask

Head harness employment was initially unmanageable. After the TPs were familiarized with the head harness, donning problems dwindled. The only problem was that the over-the-head strap of the harness would often slide to one side of the head. Doffing concept 1 required doffing the DH-132 CVC Helmet. There was not quick method of doffing the Concept 1 Face Mask.

Concept 2 Face Mask

Donning the Concept 2 Face Mask required using modified CVC goggles. A Velcro strip (hooks) was glued to the lower edge of the goggles. The Concept 2 Face Mask had a Velcro strip (eyes) attached to hold the face mask in place. Coupling the goggles and face masks was easily accomplished. The masks were further secured to the head by a single strap at the back of the head with a Velcro tab. Doffing the Concept 2 Face Mask was extremely simple. It required the TP to peel the top edge of the mask free of the goggles; however, the glue holding the Velcro on the goggles often failed. This concept did not require the DH-132 Helmet to be doffed. Complete removal of the face mask required the release of the lower head strap.

Concept 3 Face Mask

Donning the Concept 3 Face Mask was identical to that of the Concept 1 Face Mask, except that the two temple straps on the head harness were not used. Again, the over-the-head strap of the head harness would slide to one side of the head. The DH-132 Helmet and CVC goggles were then donned over the face mask.

After removing the goggles, face mask doffing was easily accomplished by disengaging the over-the-head strap from the mask. This strap would retract under the helmet, preventing strap reengagement. The face mask could easily be pulled down from the face.

COMPATIBILITY OF THE FACE MASK CONCEPTS WITH THE DH-132 CVC HELMET, IMPROVED CVC GOGGLES, AND CVC BALACLAVA

Objective

To assess compatibility of the face mask concepts with the DH-132 CVC Helmet, Improved CVC Goggles, and CVC Balaclava.

Method and Procedure

All of the TPs wore the equipment listed below throughout the evaluation. At the completion of the evaluation, the TPs were verbally debriefed on the face masks and their impact.

Equipment used in combination with the face masks were:

1. DH-132 CVC Helmet
2. Goggles, CVC, Improved
3. Balaclava, CVC

Results and Discussion

Face Masks Head Harness

Concept 1: After TP familiarization with the head harness, donning and adjustment revealed no major problems, except the metalic adjustment buckle allowed the smooth elastic strapping to slip and loosen the final adjusted fit. It should be noted that all of the face masks have a low strap that encompasses the nape of the neck. The three forehead Velcro straps had to be released for quick mask doffing with the CVC Helmet in place. After removing the CVC goggles, the mask could then be partially lowered. The straps retracted under the CVC Helmet and could not be reused.

Concept 2: The face mask was attached to the head harness by the use of Velcro. Velcro was attached to the lower exterior edge of the Improved CVC Goggles and the top interior edge of the face mask.

Quick mask doffing required the Velcro seal be broken and the mask then peeled downward. The mask was retained on the head by the lower strap that encompassed the nape of the neck. Reemployment of the Velcro strap was easily accomplished wthout doffing the CVC Helmet.

Concept 3: This head harness was identical to Concept 1 except the two temple straps were not used. The same problems (donning, ajdustment, and reemployment) were evident as in Concept 1.

Face Masks Eye Opening

Concepts 1 and 3: The eye opening did not hinder eye movement or reduce the field-of-view. The improved CVC goggles fully seated over the eye opening.

The area below the eye opening of all three face masks concepts were identical.

Face Mask Nosecover

The Velcro adjustment on the nosecover allowed the CVC helmet microphone boom to be positioned in front of the mouth. None of the TPs had negative verbal comments in regard to nosecover fit.

Compatibility with Improved CVC Goggles

Initially, the improved CVC goggles did not seal while wearing any of the face masks. The nonconforming lens did not allow the thick rubber facial cushion to seat onto the head or face masks. But, the stiff improved CVC goggle lens relaxed after a few wearings and then an acceptable seal was obtained.

Compatibility with the CVC Balaclava

The balaclava was worn underneath all of the face masks. Face mask sit was not affected while wearing the balaclava.

Compatibility with the DH-132 CVC Helmet

All of the TPs verbally reported no fit or sizing problems while wearing the DH-132 CVC Helmet with any of the face masks. All of the face masks were compatible with the CVC DH-132 Helmet.

COMPATIBILITY ASSESSMENT OF THE FACE MASK CONCEPTS WITH TANK OPTICS

Objective

To assess face mask concepts compatibility with tank optics.

Method and Procedure

Two TPs addressed each of the tank optics, listed in Table 9, with and without the face masks while wearing the DH-132 CVC Helmet. The two TPs used both sizes of the face masks; one TP wore size "small" and the other a "medium/large."

TABLE 9

Tank Optics Used

M1 Tank	
	1. Telescope
	2. Gunner's Primary Sight (GPS)
	3. Tank Commander
M60A1 Tank	
	1. M32 Gunner Primary Sight
	2. M105D Alt Gunner Sight

The optics were initially addressed with no face mask to check the field-of-view. Then, each of the face masks were randomly donned. A field-of-view assessment was made by asking the TPs if the field-of-view was reduced.

Results

All of the face mask concepts were found to be compatible with the tank optics listed in Table 9. The TPs also verbally reported no reduction in field-of-view with the face mask concepts.

SUBJECTIVE MEASURES

Introduction

Throughout the testing the subjects would naturally evaluate and construct attitudes and opinions which were based solely on the recent exposure to the face masks. An approach to evaluate subjective data was made by using a Modified Semantic Differential Rating Scale[1]. The data

[1] Osgood, C.E., Succi, G.J., & Tannenbaum, P.H. The measurement of meaning. Urbana, IL: University of Illinois Press, 1965.

were obtained by using special constructed questionnaires, wherein the subjects rated Concepts 1 and 3 CVC face masks against the Concept 2 face mask. Comparisons covered a number of operational/functional characteristics of the face masks.

Method

The Modified Semantic Differential Rating Scale Questionnaire consists of a number of "bipolar" pairs of adjective (adverbs, adjective phrases, or adverbial phrases are also used). An example of bipolar pairs can be seen in Figure 2.

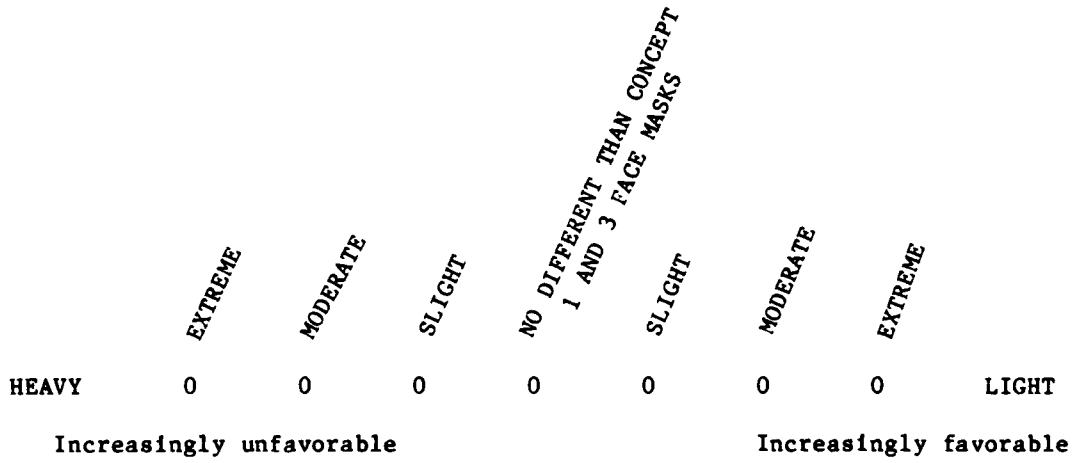


Figure 2. Format for semantic differential scales.

A number of important concepts are incorporated in the construction of this type of scale. First, the midpoint or center of the scale represents Concepts 1 and 3. Concepts 1 and 3 served as an "anchor" point for each adjective pair for every comparative judgment. The adjectives at the scale endpoints are chosen to represent the extremes of a contiuum for a given evaluative dimension such as location and effectiveness. In this example, "heavy" and "light" are opposite poles on the continuum of weight, and are referred to as "bipolar."

Next, depending on the polarity of a given adjective pair, movement to the left or right of the anchor point represents an increasingly favorable or unfavorable judgment. Finally, the scale point modifiers, "slight," "moderate," and "extreme," are positioned to reflect this increasing magnitude of judgment as one approaches the adjective endpoints.

When a number of adjective pairs are collected to form a questionnaire, polarity is counterbalanced, as seen in Figure 3, with first a positive and then a negative adjective appearing on the left as one does down the list.

The questionnaires utilized are shown in Appendix B.

HEAVY.....LIGHT

RUGGED.....FLIMSY

. .

. .

. .

LOSES SHAPE.....HOLDS SHAPE

Figure 3. Counterbalancing S.D. adjective pairs for polarity.

This counterbalancing, or alternating of polarity, is done to discourage subjects from perseverating; i.e., from choosing a pattern of predominatly left or right responses without regard to adjective meaning. The M.S.D. technique was chosen over a number of possible rating scale techniques because of the following advantages:

1. Flexibility of choice - adjective pairs can be chosen to evaluate specific, detailed characteristics of an item.

2. Rapid administration - subjects are required to make one and only one response per adjective pair.

3. Ease of checking by data collectors in the field - forms can be quickly scanned to check perseveration, tendency toward extreme responses, lack of internal consistency, and completeness.

Procedure

Preliminary development of the questionnaire began with the selection of adjective/adverb pairs and uniform characteristics to be assessed. Individual briefing sessions were held to insure familiarization with the Modified Semantic Differential Rating Scale Questionnaire. The questionnaire was designed to assess uniform performance in the following areas:

1. Material
2. Fit (static)
3. Fasteners/Closures
4. Working in the face masks (dynamics)

Results

The Modified Semantic Differential Rating Scale Questionnaire, from 12 subjests, used a total of 34 adjective pairs and produced 816 responses. As shown in Figure 4, numerical values from 1 to 7 were assigned to each scale position with a value of 1 always given to the "extreme" modifier at the negative pole of the adjective pair.

HEAVY	0	0	0	0	0	0	0	LIGHT
	1	2	3	4	5	6	7	
BALANCED	0	0	0	0	0	0	0	UNBALANCED
	7	6	5	4	3	2	1	

Figure 4. Assignment of numerical values to M.S.D. scale positions.

The mean and standard deviations of subject scaled scores for each adjective pair are summarized in Tables 10 and 11. A means scaled score less than 3.0 is considered to be a practically significant disadvantage/-negative feature; any mean scaled score greater than 5.0 is considered to be a practically significant advantage/positive feature. The mean scaled scores were also graphically displayed in Figures 2 thru 9 to provide the reader with a rapid means of comparison against Concepts 1 and 3. The mean scale scores falling within $\pm$ one scale division of the baseline are not considered practically significant.

TABLE 10

CVC Spall Face Mask Modified Semantic Differential Rating Questionnaire 1980

	Concept 1 Versus 2 Mean	S.D.	Concept 3 Versus 2 Mean	S.D.
Material				
Smooth/Rough	4.0	0.53	4.1	0.35
Thin/Thick	3.9	0.64	4.4	0.52
Light/Heavy	4.0	0.93	3.7	0.71
Rugged/Flimsy	3.9	0.83	3.9	0.83
Good Durability/Poor Durability	4.1	1.13	4.1	0.83
Holds Shape/Loses Shape	3.9	0.35	3.7	0.71
Good Construct/Poor Construct	3.6	0.92	4.0	0.76
Good Absorpt/Poor Absorpt	4.1	0.35	4.0	0.00
Quick Drying/Slow Drying	4.1	0.83	4.1	0.35
Easy to Clean/Hard to Clean	4.4	0.74	4.0	0.00
Fit (Static)				
Trim/Bulky	3.6	1.19	4.1	0.83
Good Fit/Poor Fit	3.9	0.99	3.4	0.92
Loose/Tight	4.3	0.71	4.6	0.92
Long/Short	4.4	1.30	4.5	0.76
Good Proport/Poor Proport	3.6	0.74	4.1	0.64
Easy Quick Don/Hard Slow Don	3.6	1.19	3.5	0.76
Easy Quick Doff/Hard Slow Doff	4.0	1.51	4.4	0.74
Comfortable/Uncomfortable	3.7	0.71	3.6	0.74
Fasteners/Closures				
Adequate Adjust/Inadequate Adjust	4.1	0.64	3.4	0.52
Rugged/Flimsy	4.1	0.64	4.1	0.64
Effective/Ineffective	4.4	1.19	3.6	0.52
Well Located/Poorly Located	3.7	0.71	3.6	0.52
Easy to Grip/Hard to Grip	3.7	0.46	3.6	0.74
Easy to Adjust/Hard to Adjust	3.3	0.71	4.0	0.76
Hold Adjust/Lose Adjust	4.1	0.35	4.0	0.93
Working in the Spall Face Mask (Dynamics)				
Smooth/Rough on Skin	3.7	0.71	4.0	0.00
Dry/Sweaty	3.9	0.35	4.0	0.00
Cool/Hot	4.6	0.74	4.0	0.00
Trim/Bulky	3.9	0.99	4.1	0.83
Stays Flat/Bunches Up	4.1	0.64	4.1	0.99
Aids Movement/Restricts Movement	3.3	0.71	3.6	0.52
Moves Freely/Binds (Body Part)	4.0	0.53	3.7	0.46
Comfortable/Uncomfortable	3.5	0.93	4.0	0.93
Compatible/Incompatible	3.7	0.46	4.1	0.35

RESULTS

There were no differences in positive or negative features identified by the Modified S. D. Scales. The concepts were so alike that little differences were perceived by the TPs.

CONCLUSIONS

All the face mask concepts were compatible with the associated equipment in the operational environment.

Face Mask Concept 2 appears to be the most desirable face mask concept because of the following:

1. There is no head harness underneath the CVC Helmet.

2. No possibility of head harness breakage.

3. Limited training is required to learn to correctly don and doff the mask.

4. Capability of quick mask doffing and redonning without disturbing other headwear.

RECOMMENDATIONS

It is recommended that Face Mask Concept 2 be considered for further evaluation with the following modifications:

1. Replace the slippery elastic nape strap with a nonslippery nonelastic strap. Retain the connecting elastic strap with Velcro tab (see Figure 13).

2. Affix the Velcro (hooks) strip permanently to the Improved CVC Goggles. These Velcro hooks could also be used to anchor the balaclava's nosecover.

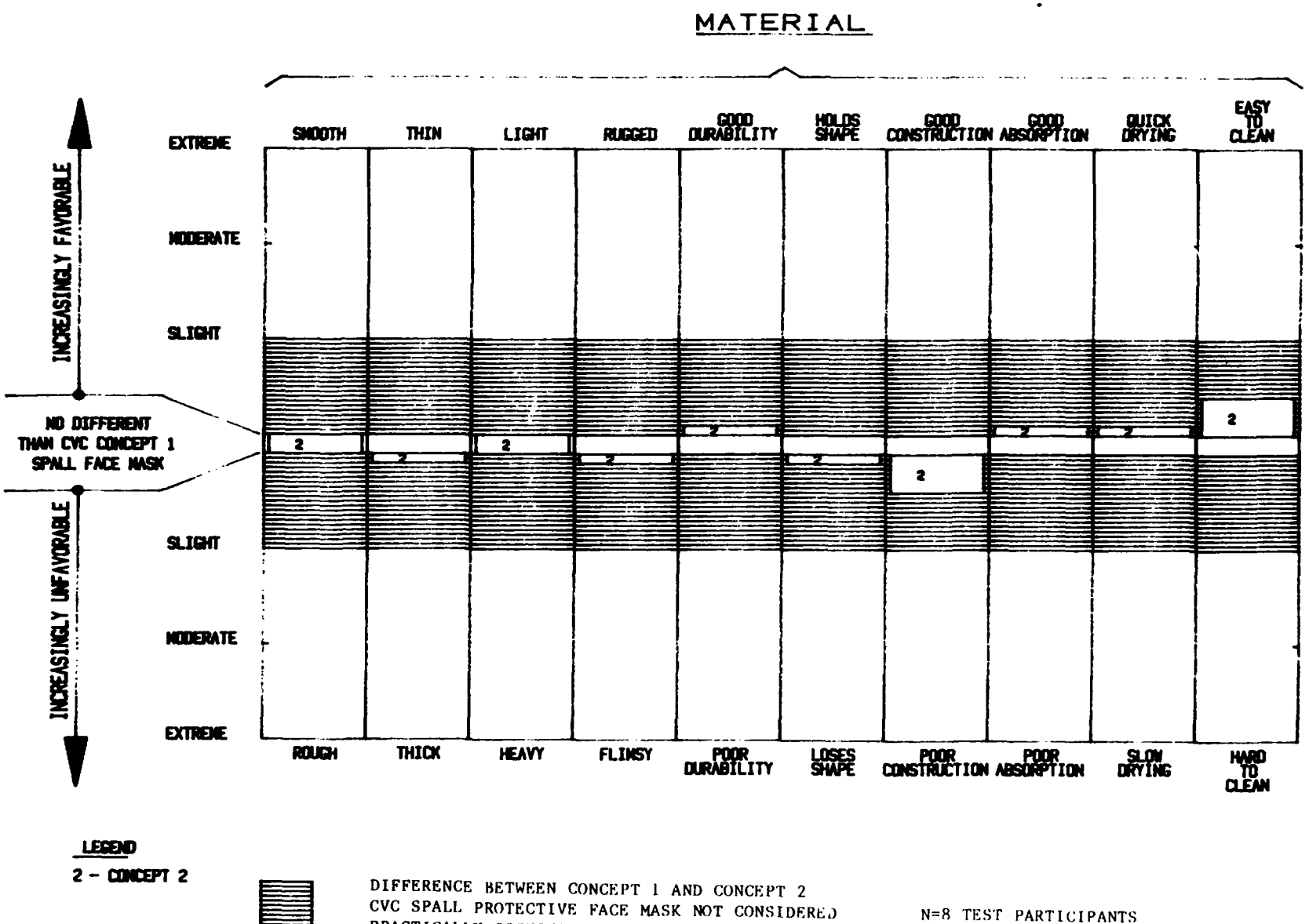


Figure 5. Concept 1 face mask compared to Concept 2 face mask-material.

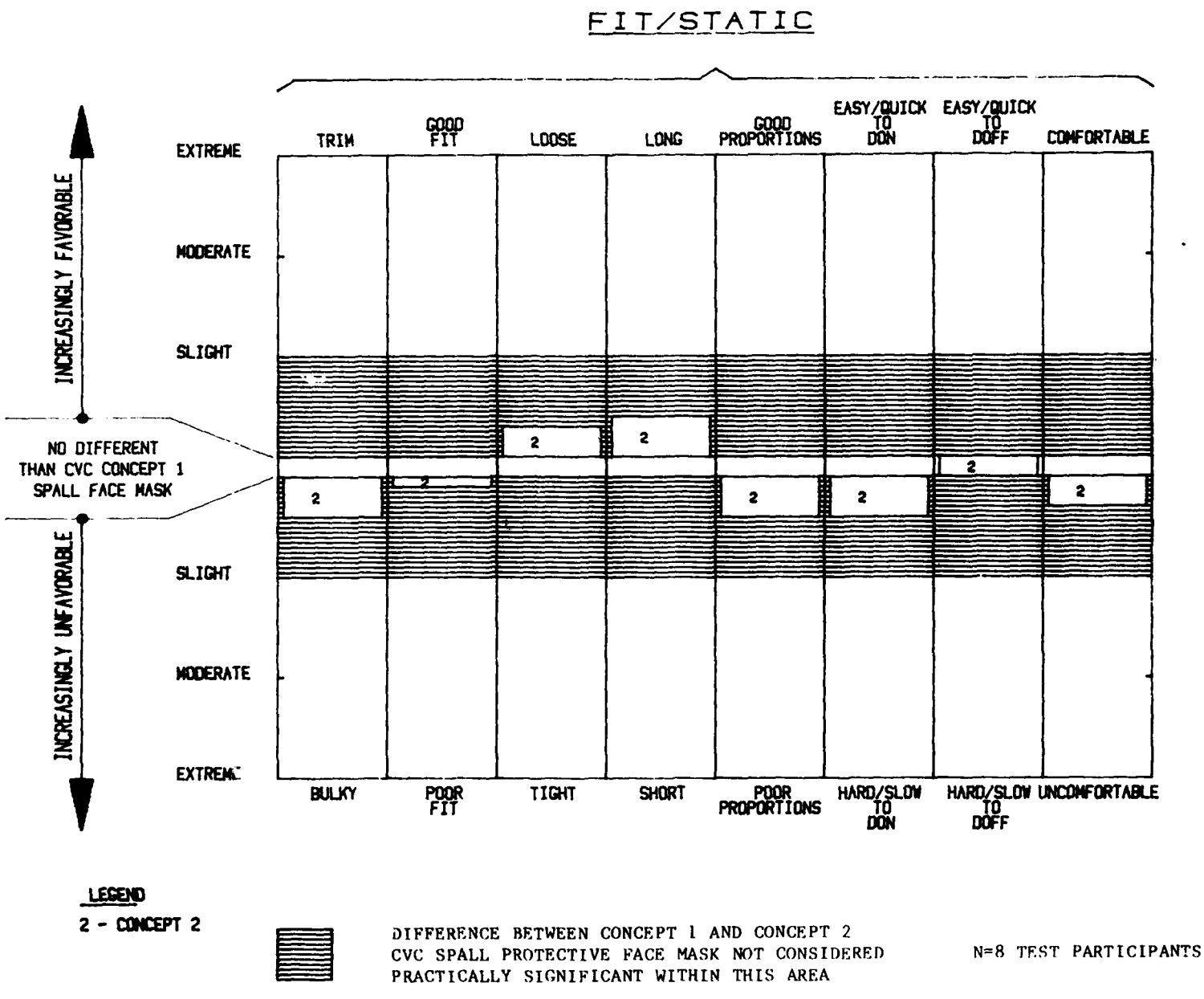


Figure 6. Concept 1 face mask compared to Concept 2 face mask-fit/static.

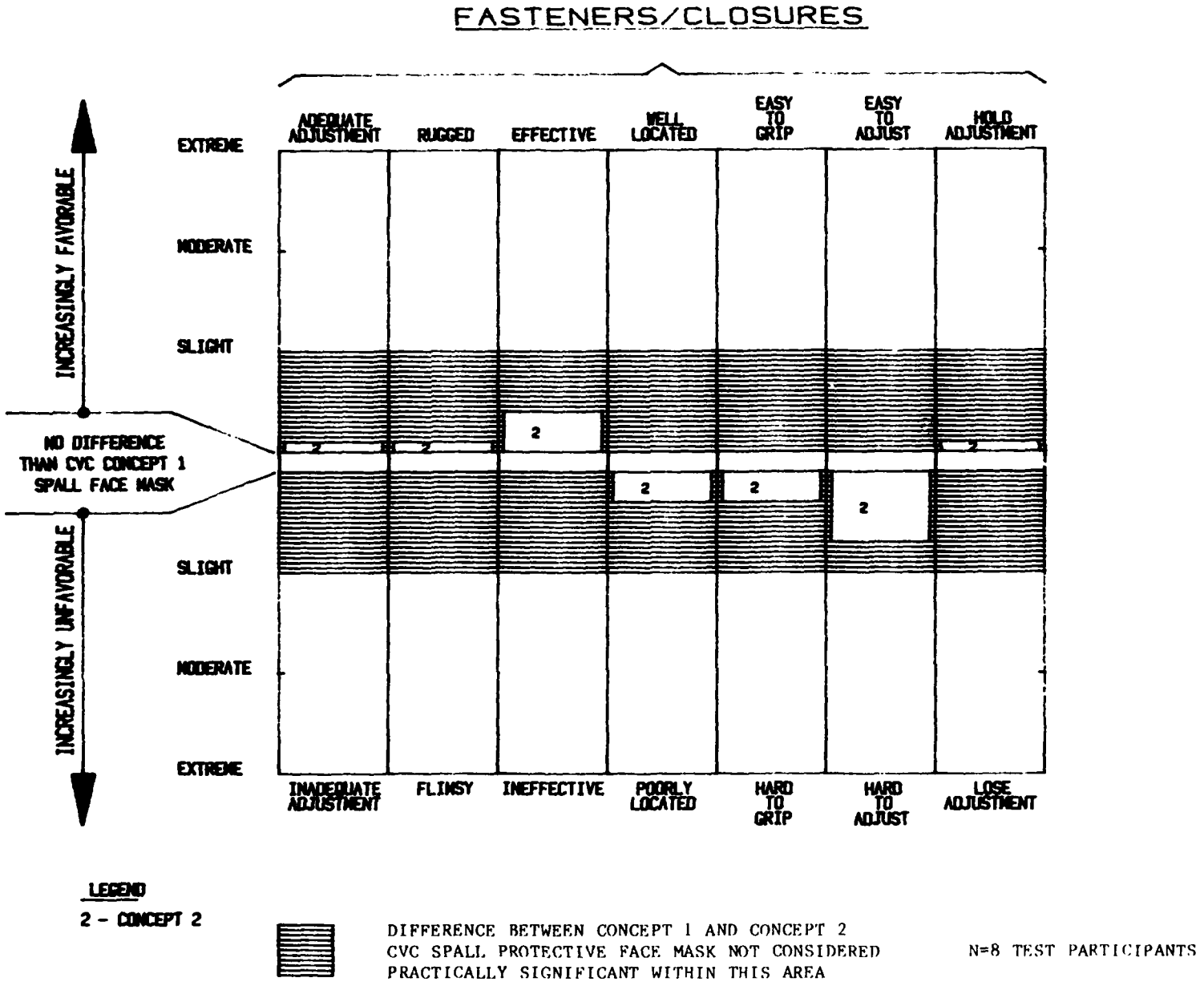


Figure 7. Concept 1 face mask compared to Concept 2 face mask-fasteners/closures.

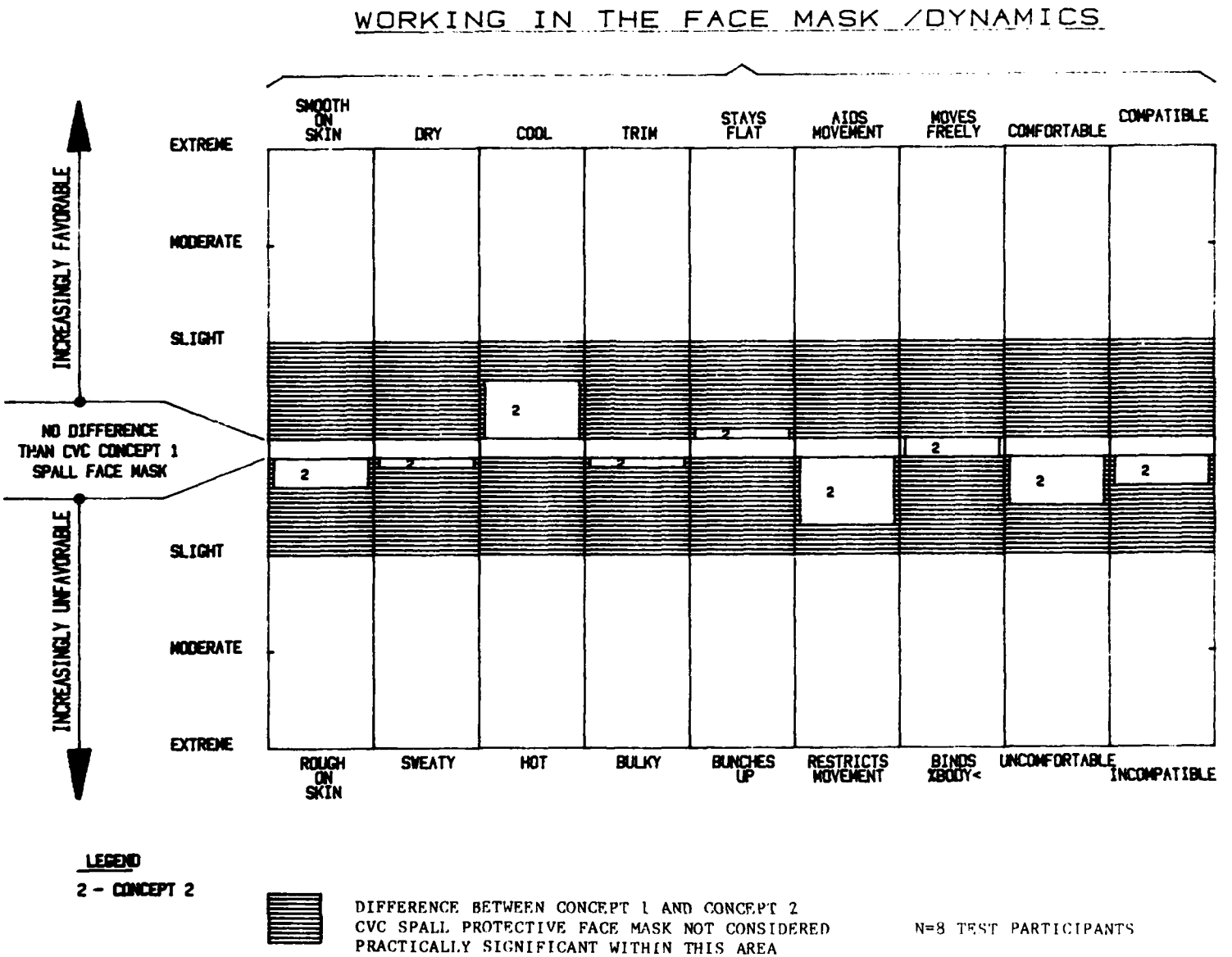


Figure 8. Concept 1 face mask compared to Concept 2 face mask-working in the face mask.

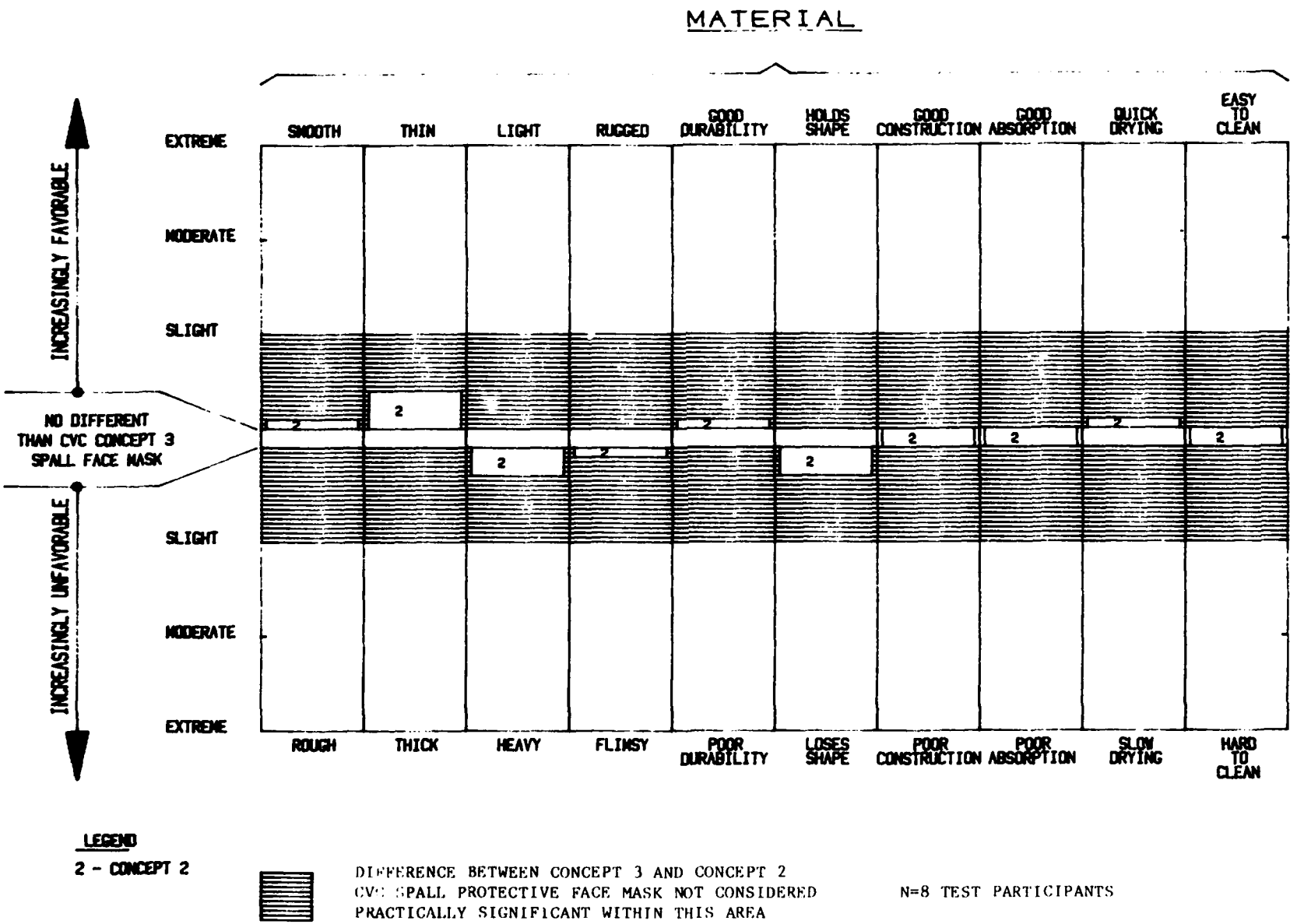


Figure 9. Concept 3 face mask compared to Concept 2 face mask-material.

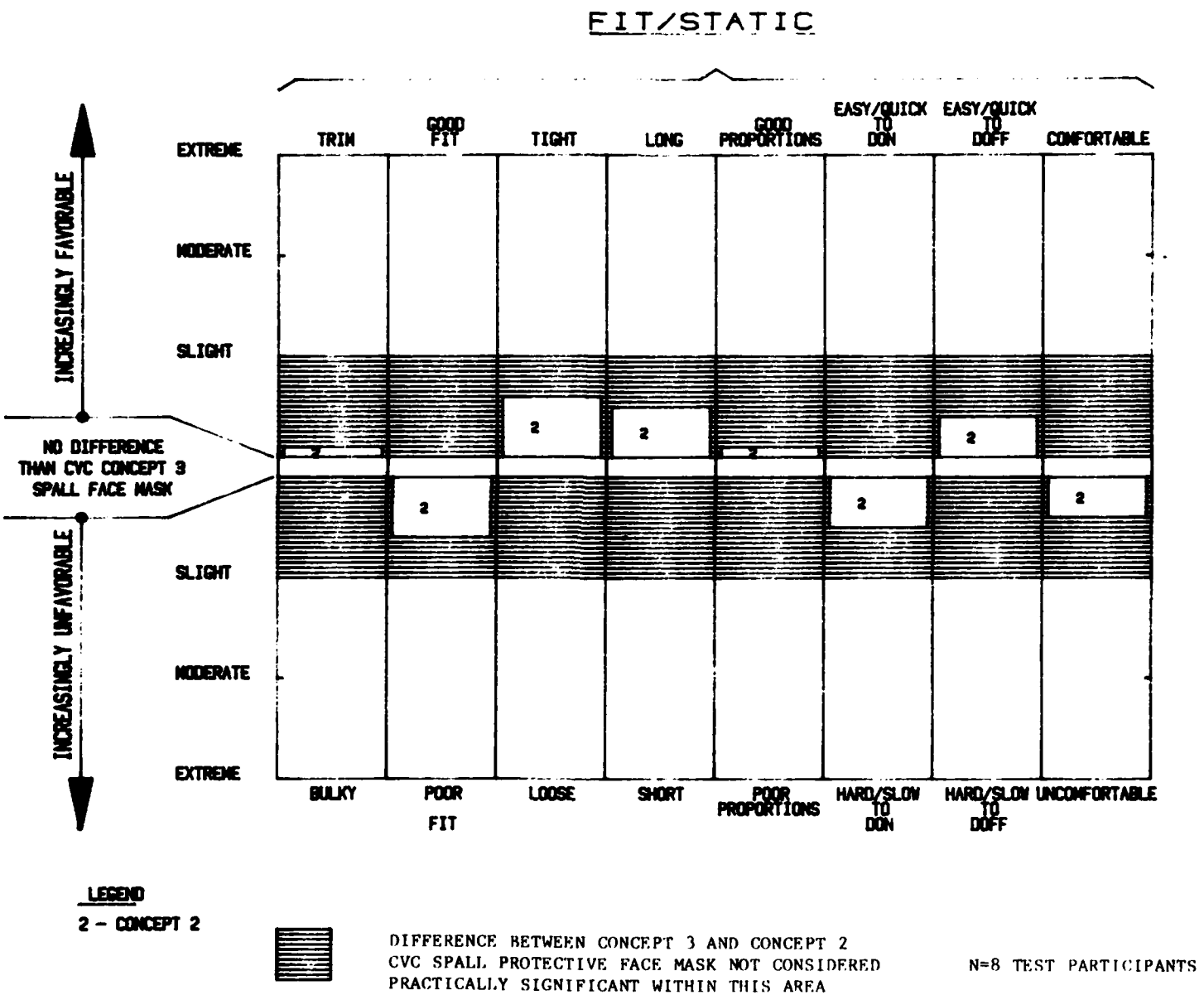


Figure 10. Concept 3 face mask compared to Concept 2 face mask-fit/static.

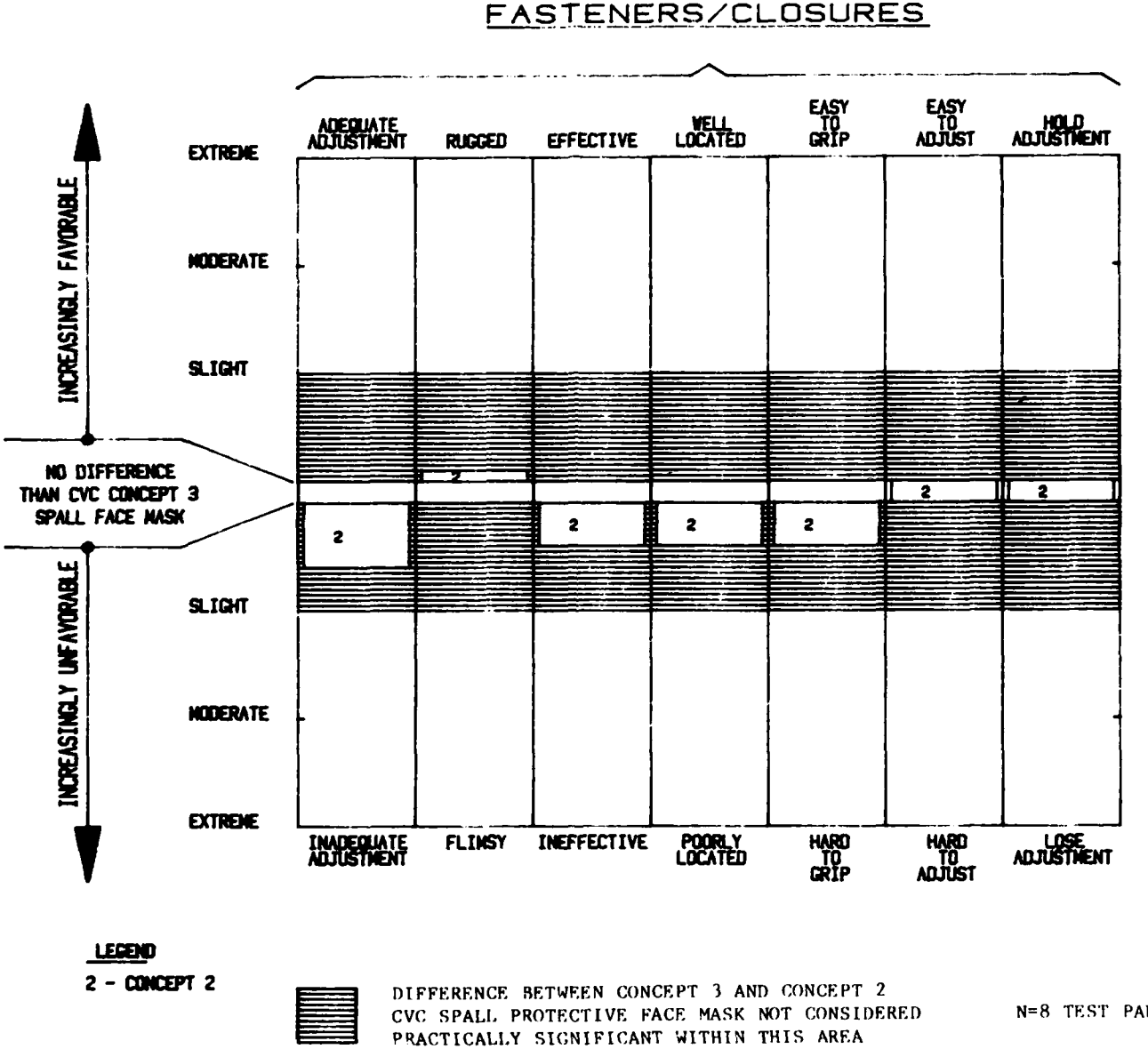


Figure 11. Concept 3 face mask compared to Concept 2 face mask-fasteners/closures.

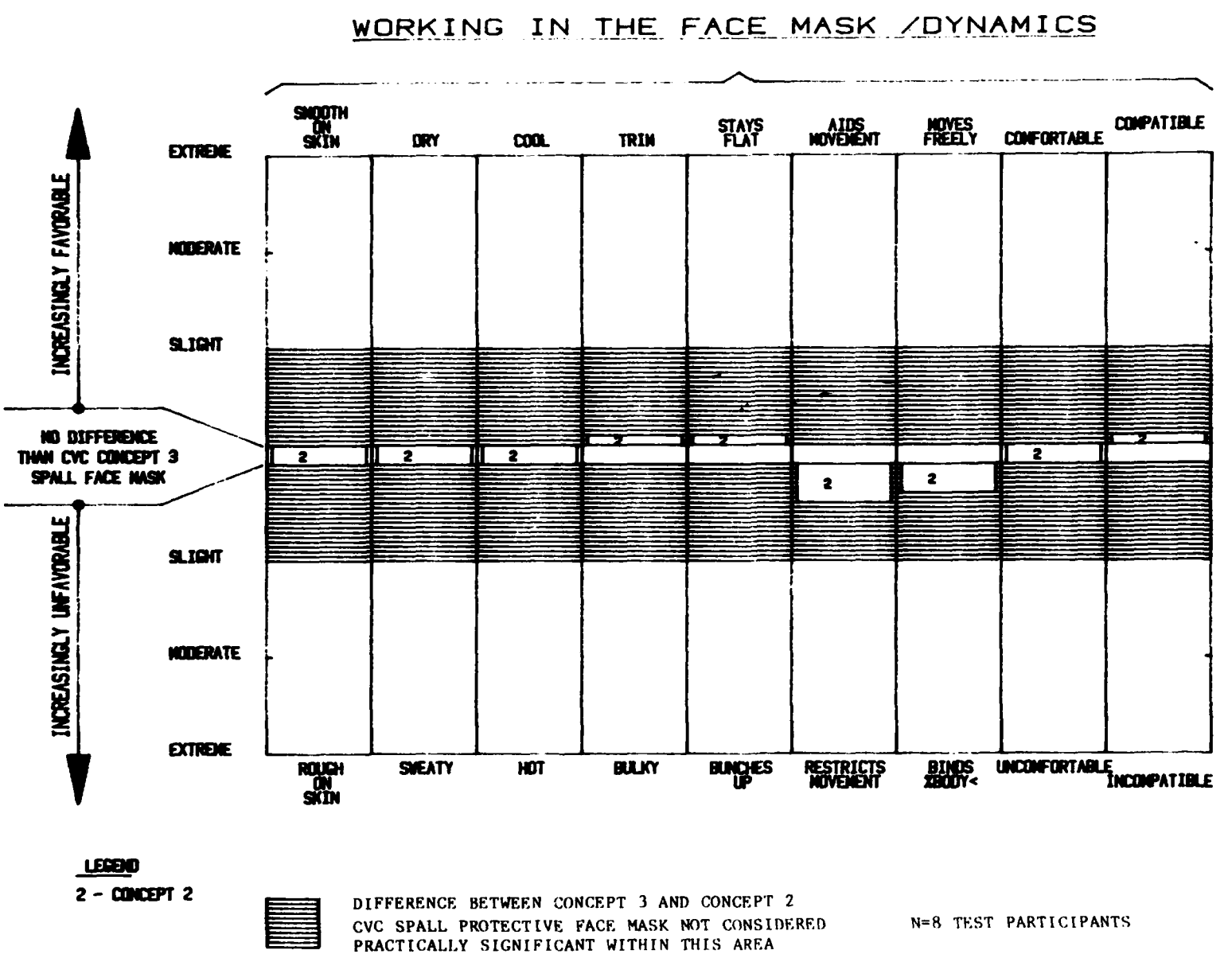


Figure 12. Concept 3 face mask compared to Concept 2 face mask-working in the face mask.

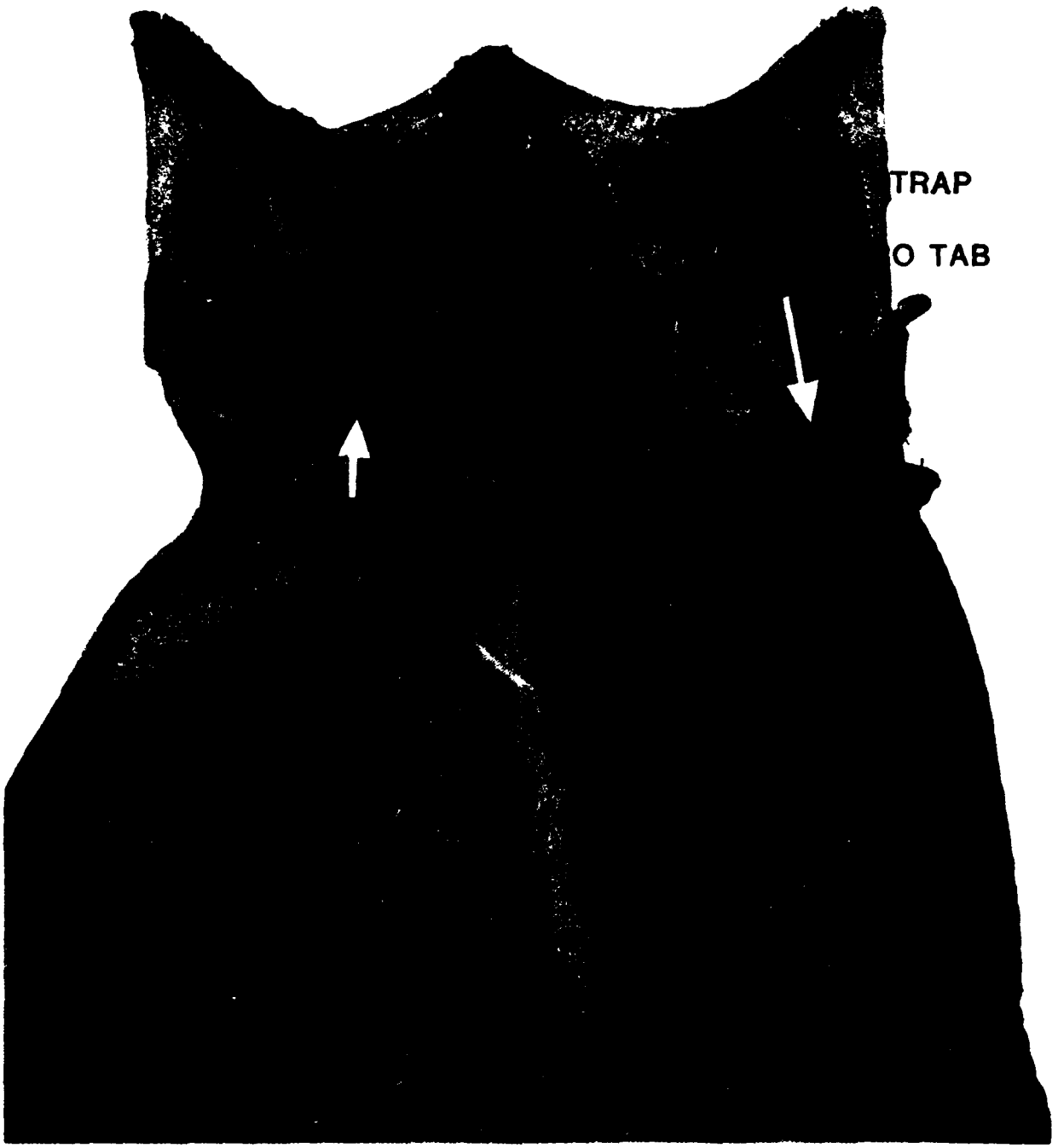


Figure 13. Recommend the replacement of the slippery elastic nape strap with a nonslippery nonelastic strap. Retain the connecting elastic strap with Velcro tab.

APPENDIX A

FACT SHEET--FACE MASK CONCEPTS

FACT SHEET

ITEM NAME: Face Mask, Spall, Flame, Dust, Wind Protective

Concept 1

CLIMATIC CATEGORY: Zones I thru VII

CONCEPT OF USE: This mask is intended to provide facial protection against low-velocity fragments, flame, dust, and wind to armored vehicle crewmen. It can be worn with or without removing the helmet or balaclava. It has a single opening for the eyes, an adjustable elastic head harness, a bib and cloth air filter. The cloth air filter is attached in the neck area with three ties, and when it is not in use, it is rolled tucked under the chin, and held with hook-and-pile fastener tape. When needed, the air filter is easily unrolled and held over the nose and mouth by hook and pile fastener tape. The mask also has a soft aluminum strip between the Kevlar layers which can be pressed to the shape of the face to minimize fogging of the goggles.

MATERIALS USED:

Outer Layer - Cloth, Nomex, woven, 153 gm/m^2 (4.5 oz/yd^2)
Inside Layer - Cloth, cotton, rip-stop, 203 gm/m^2 (6.0 oz/yd^2)
Ballistic Protective Layers (3) - Cloth, Aramid (Kevlar), 1000 denier, water repellent finished, 279 gm/m^2 (8.5 oz/yd^2)

COLOR: Olive Green

WEIGHT: Approximately 4.5 oz.

SIZE: 2 Sizes - Medium-Large, Small

COST: $35.00

(Concept 2)

DESCRIPTION: This concept utilizes only the lower portion of the mask described in Concept 1. The upper edge of the mask is contoured to the shape of the goggles and is fastened to the goggles by means of hook-and-pile fastener tape. A kit containing all components for applying the hook fastener tape to the goggles is furnished with the mask. Because the goggles affect the seal between the goggles and the face, there is no need for special provisions on the mask to prevent fogging of the goggles. All other features found below the eye and nose area in Concept 1 are applicable to Concept 2.

ITEM NAME: Face Mask, Spall, Flame, Dust, Wind Protective

Change made in the redesign of the face mask.

CONCEPT 1

1. Eye opening reshaped to a single opening in the configuration of the goggle opening.

2. Height of the mask above the eyehole was reduced to minimize interference with the helmet.

3. Nose cover was widened to reduce pressure on the nose.

4. Chin of the mask was lengthened to allow unrestricted movement of the chin while talking.

5. "Press to shape" seal was introduced to nose area to prevent fogging of the goggles.

6. Adjustment capability was added to harness straps.

7. The harness was redesigned to allow the mask to be pulled down around the neck without removing the helmet or balaclava.

8. The air filter was redesigned and attached to the mask so that it can be rolled and stored under the chin when not in use.

9. The inner fabric was change to a 6 oz. rip-stop cotton to allow better construction and increase durability.

10. The bib was shortened and narrowed.

CONCEPT 2

1. This concept utilizes only the lower portion of the face mask.

2. The mask attaches to the goggles by means of Velcro hook and pile tape.

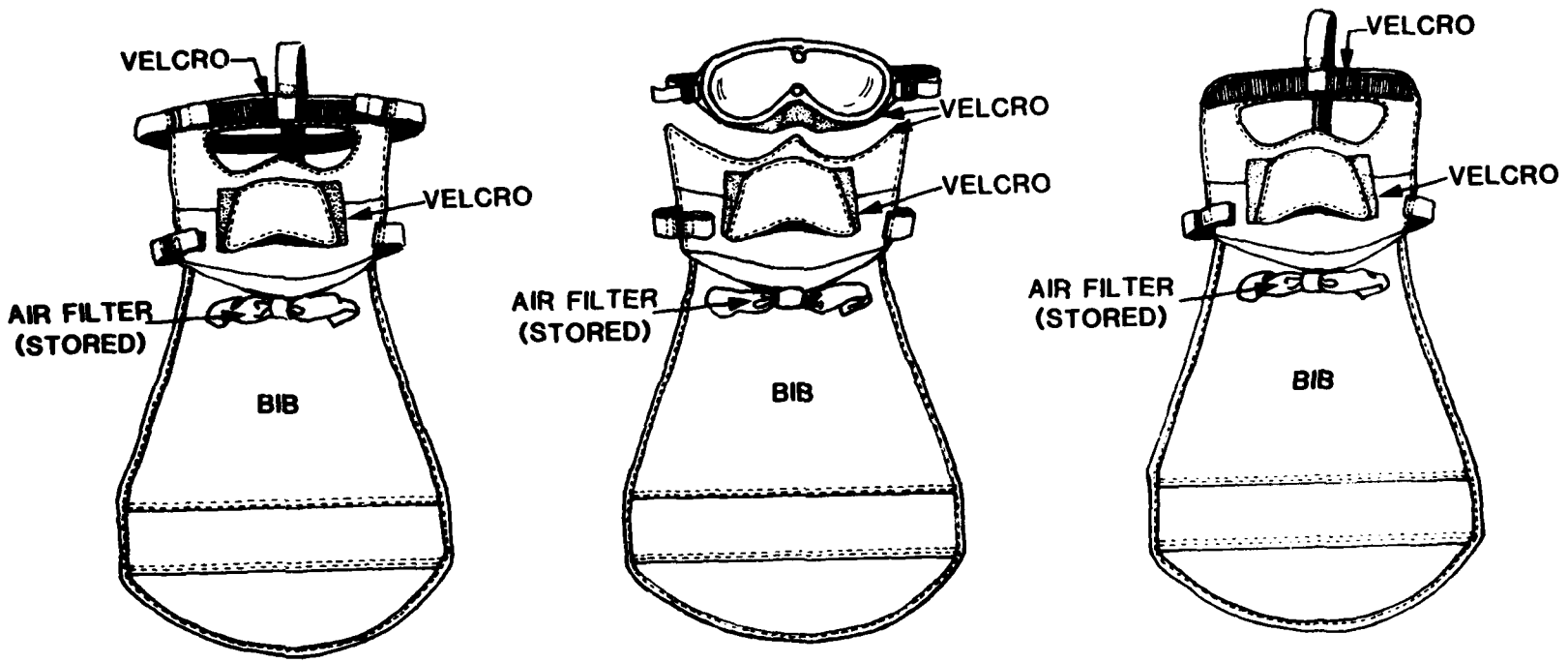
3. Only the lower elastic strap is used.

4. All other features below the eye and nose area in Concept 1 are applicable to Concept 2.

CONCEPT 3

Concept 3 is the same as Concept 2 except the temple head strap harness was not used.

FACE MASK-SPALL, FLAME, DUST, WIND PROTECTIVE



CONCEPT 1

CONCEPT 2

CONCEPT 3

APPENDIX B

MODIFIED SEMANTIC DIFFERENTIAL RATING SCALE

FOR THE SPALL FACE MASKS

CVC SPALL FACE MASK RATING SCALE

NAME_____ POSITION_____

	EXTREME	MODERATE	SLIGHT	CONCEPT 1 FACE MASK	SLIGHT	MODERATE	EXTREME	
				MATERIAL				
SMOOTH	0	0	0	0	0	0	0	ROUGH
THIN	0	0	0	0	0	0	0	THICK
HEAVY	0	0	0	0	0	0	0	LIGHT
FLIMSY	0	0	0	0	0	0	0	RUGGED
GOOD DURABILITY	0	0	0	0	0	0	0	POOR DURABILITY
LOSES SHAPE	0	0	0	0	0	0	0	HOLDS SHAPE
GOOD CONSTRUCTION	0	0	0	0	0	0	0	GOOD CONSTRUCTION
POOR ABSORPTION	0	0	0	0	0	0	0	GOOD ABSORPTION
QUICK DRYING	0	0	0	0	0	0	0	SLOW DRYING
HARD TO CLEAN	0	0	0	0	0	0	0	EASY TO CLEAN
				FIT				
TRIM	0	0	0	0	0	0	0	BULKY
POOR FIT	0	0	0	0	0	0	0	GOOD FIT
LOOSE	0	0	0	0	0	0	0	TIGHT
LONG	0	0	0	0	0	0	0	SHORT
GOOD PROPORTIONS	0	0	0	0	0	0	0	POOR PROPORTIONS
HARD/SLOW TO DON	0	0	0	0	0	0	0	EASY/QUICK TO DON
EASY/QUICK TO DOFF	0	0	0	0	0	0	0	HARD/SLOW TO DOFF
UNCOMFORTABLE	0	0	0	0	0	0	0	COMFORTABLE

CVC SPALL FACE MASK RATING SCALE (Continued)

	EXTREME	MODERATE	SLIGHT	CONCEPT 1 FACE MASK	SLIGHT	MODERATE	EXTREME	
FASTENERS/CLOSURES								
INADEQUATE ADJUSTMENT	0	0	0	0	0	0	0	ADEQUATE ADJUSTMENT
RUGGED	0	0	0	0	0	0	0	FLIMSY
INEFFECTIVE	0	0	0	0	0	0	0	EFFECTIVE
WELL LOCATED	0	0	0	0	0	0	0	POORLY LOCATED
HARD TO GRIP	0	0	0	0	0	0	0	EASY TO GRIP
EASY TO ADJUST	0	0	0	0	0	0	0	HARD TO ADJUST
LOSE ADJUSTMENT	0	0	0	0	0	0	0	HOLD ADJUSTMENT
WORKING IN THE CVC FACE MASK (DYNAMICS)								
ROUGH ON SKIN	0	0	0	0	0	0	0	SMOOTH ON SKIN
DRY	0	0	0	0	0	0	0	SWEATY
HOT	0	0	0	0	0	0	0	COOL
TRIM	0	0	0	0	0	0	0	BULKY
BUNCHES UP	0	0	0	0	0	0	0	STAYS FLAT
AIDS MOVEMENT	0	0	0	0	0	0	0	RESTRICTS MOVEMENT
BINDS (BODY PART)	0	0	0	0	0	0	0	MOVES FREELY
COMFORTABLE	0	0	0	0	0	0	0	UNCOMFORTABLE
INCOMPATIBLE	0	0	0	0	0	0	0	COMPATIBLE

CVC SPALL FACE MASK RATING SCALE

NAME_____ POSITION_____

	EXTREME	MODERATE	SLIGHT	CONCEPT 3 FACE MASK	SLIGHT	MODERATE	EXTREME	
				MATERIAL				
SMOOTH	0	0	0	0	0	0	0	ROUGH
THIN	0	0	0	0	0	0	0	THICK
HEAVY	0	0	0	0	0	0	0	LIGHT
FLIMSY	0	0	0	0	0	0	0	RUGGED
GOOD DURABILITY	0	0	0	0	0	0	0	POOR DURABILITY
LOSES SHAPE	0	0	0	0	0	0	0	HOLDS SHAPE
GOOD CONSTRUCTION	0	0	0	0	0	0	0	GOOD CONSTRUCTION
POOR ABSORPTION	0	0	0	0	0	0	0	GOOD ABSORPTION
QUICK DRYING	0	0	0	0	0	0	0	SLOW DRYING
HARD TO CLEAN	0	0	0	0	0	0	0	EASY TO CLEAN
				FIT				
TRIM	0	0	0	0	0	0	0	BULKY
POOR FIT	0	0	0	0	0	0	0	GOOD FIT
LOOSE	0	0	0	0	0	0	0	TIGHT
LONG	0	0	0	0	0	0	0	SHORT
GOOD PROPORTIONS	0	0	0	0	0	0	0	POOR PROPORTIONS
HARD/SLOW TO DON	0	0	0	0	0	0	0	EASY/QUICK TO DON
EASY/QUICK TO DOFF	0	0	0	0	0	0	0	HARD/SLOW TO DOFF
UNCOMFORTABLE	0	0	0	0	0	0	0	COMFORTABLE

CVC SPALL FACE MASK RATING SCALE (Continued)

CONCEPT 3 FACE MASK

	EXTREME	MODERATE	SLIGHT		SLIGHT	MODERATE	EXTREME	
FASTENERS/CLOSURES								
INADEQUATE ADJUSTMENT	0	0	0	0	0	0	0	ADEQUATE ADJUSTMENT
RUGGED	0	0	0	0	0	0	0	FLIMSY
INEFFECTIVE	0	0	0	0	0	0	0	EFFECTIVE
WELL LOCATED	0	0	0	0	0	0	0	POORLY LOCATED
HARD TO GRIP	0	0	0	0	0	0	0	EASY TO GRIP
EASY TO ADJUST	0	0	0	0	0	0	0	HARD TO ADJUST
LOSE ADJUSTMENT	0	0	0	0	0	0	0	HOLD ADJUSTMENT
WORKING IN THE CVC FACE MASK (DYNAMICS)								
ROUGH ON SKIN	0	0	0	0	0	0	0	SMOOTH ON SKIN
DRY	0	0	0	0	0	0	0	SWEATY
HOT	0	0	0	0	0	0	0	COOL
TRIM	0	0	0	0	0	0	0	BULKY
BUNCHES UP	0	0	0	0	0	0	0	STAYS FLAT
AIDS MOVEMENT	0	0	0	0	0	0	0	RESTRICTS MOVEMENT
BINDS (BODY PART)	0	0	0	0	0	0	0	MOVES FREELY
COMFORTABLE	0	0	0	0	0	0	0	UNCOMFORTABLE
INCOMPATIBLE	0	0	0	0	0	0	0	COMPATIBLE

APPENDIX C

NLABS INSTRUCTIONS FOR USE OF FACE MASK, COMBAT VEHICLE CREWMEN'S FLAME, DUST, WIND, FRAGMENTATION PROTECTIVE CONCEPTS 1 AND 2

INSTRUCTIONS FOR USE OF FACE MASK, COMBAT VEHICLE CREWMEN'S

FLAME, DUST, WIND, FRAGMENTATION PROTECTIVE

(CONCEPT 1)

1. Position the mask on your face and attach all harness straps.

2. Adjust the neck strap and the overhead strap using the slide buckles. Adjust the top strap by moving the ends along the Velcro hook at the top of the mask.

3. Press the mask in the nose and upper cheek area to make the mask fit close to your face. This will help prevent fogging of your goggles.

4. Have a buddy lock the straps by turning the end of each strap over the slide buckle and into the farthest slot of the slide buckle. If you must do it yourself, gently detach the Velcro fasteners and remove the mask and lock in the straps. Try the mask on again. If it is too loose or too tight, readjust it.

5. To put your mask on after the adjustments are made, just attach the Velcro at the neck and forehead.

6. If you're in action and you want to remove the mask, disengage the Velcro tabs at the forehead and pull the mask down below your chin. To replace the mask, lift the mask and reattach the Velcro tabs.

7. To use the dust protector, separate the Velcro holder under the chin, unroll the protector and press it into place around the nose.

INSTRUCTIONS FOR USE OF FACE MASK, COMBAT VEHICLE CREWMEN'S

FLAME, DUST, WIND, FRAGMENTATION PROTECTIVE

(CONCEPT 2)

1. When you get your face mask, make sure you have goggles with a Velcro hook located at the lower edge of the goggle.

2. Fasten the upper edge of the mask to the Velcro hook at the bottom edge of the goggles.

3. Put the mask on and press the Velcro tab of the neck strap to the hook on the mask. Adjust the straps of the goggles and the mask using the slide adjusters.

4. Adjust the nose flap so there is no pressure on the nose.

5. If you're in action and you want to remove the mask, disengage the mask from the goggles and pull the mask down below your chin. To replace the mask, lift the mask and reattach the Velcro.

6. To use the dust protector, separate the Velcro holder under the chin, unroll the protector and press it into place around the nose.

INSTRUCTIONS FOR USE OF FACE MASK, COMBAT VEHICLE CREWMEN'S

FLAME, DUST, WIND, FRAGMENTATION PROTECTIVE

(CONCEPT 3)

1. Position the mask on your face and attach all harness straps.

2. Adjust the neck strap and the overhead strap using the slide buckles. Adjust the top strap by moving the ends along the Velcro hook at the top of the mask.

3. Press the mask in the nose and upper cheek area to make the mask fit close to your face. This will help prevent fogging of your goggles.

4. Have a buddy lock the straps by turning the end of each strap over the slide buckle and into the fartherest slot of the slide buckle. If you must do it yourself, gently detach the Velcro fasteners and remove the mask and lock in the straps. Try the mask on again. If it is too loose or too tight, readjust it.

5. To put your mask on after the adjustments are made, just attach the Velcro at the neck and forehead.

6. If you're in action and you want to remove the mask, disengage the Velcro tabs and the forehead and pull the mask down below your chin. To replace the mask, lift the mask and reattach the Velcro tabs.

7. To use the dust protector, separate the Velcro holder under the chin, unroll the protector and press it into place around the nose.

APPENDIX D

ILLUSTRATIONS OF THE FACE MASK CONCEPTS

Figure 1D. Face mask Concept 1 on head form.

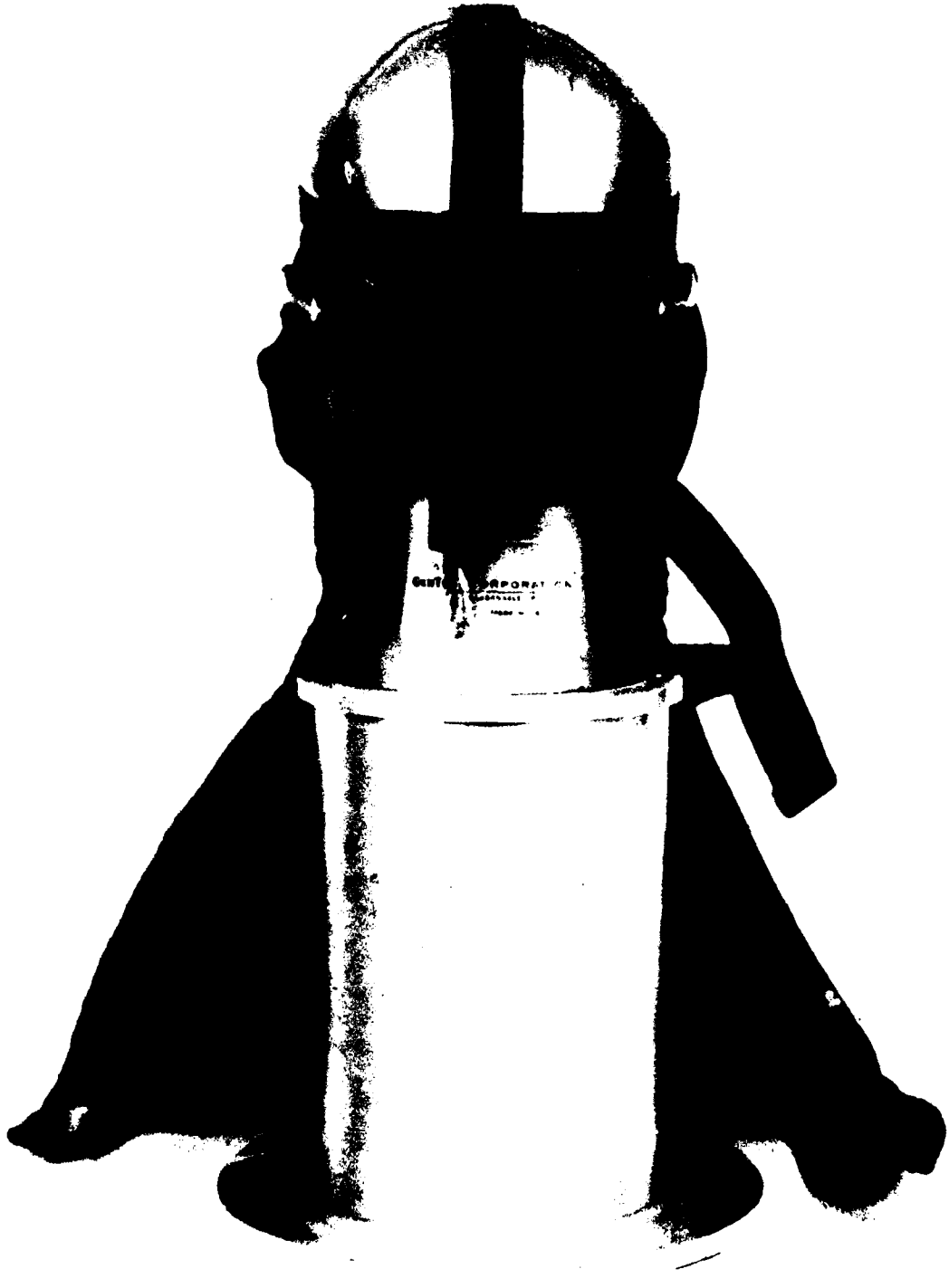


Figure 2D. Face mask Concept 1 head harness, rear view, on head form.

Figure 3D. Face mask Concept 1 head harness with DH 132 CVC Helmet and improved CVC goggles.

Figure 4D. Face mask Concept 2 on head form with DH 132 Helmet and modified improved CVC goggles.

Figure 5D. Face mask Concept 2 on head form with DH 132 Helmet and modified improved CVC goggles - quick doff mode.

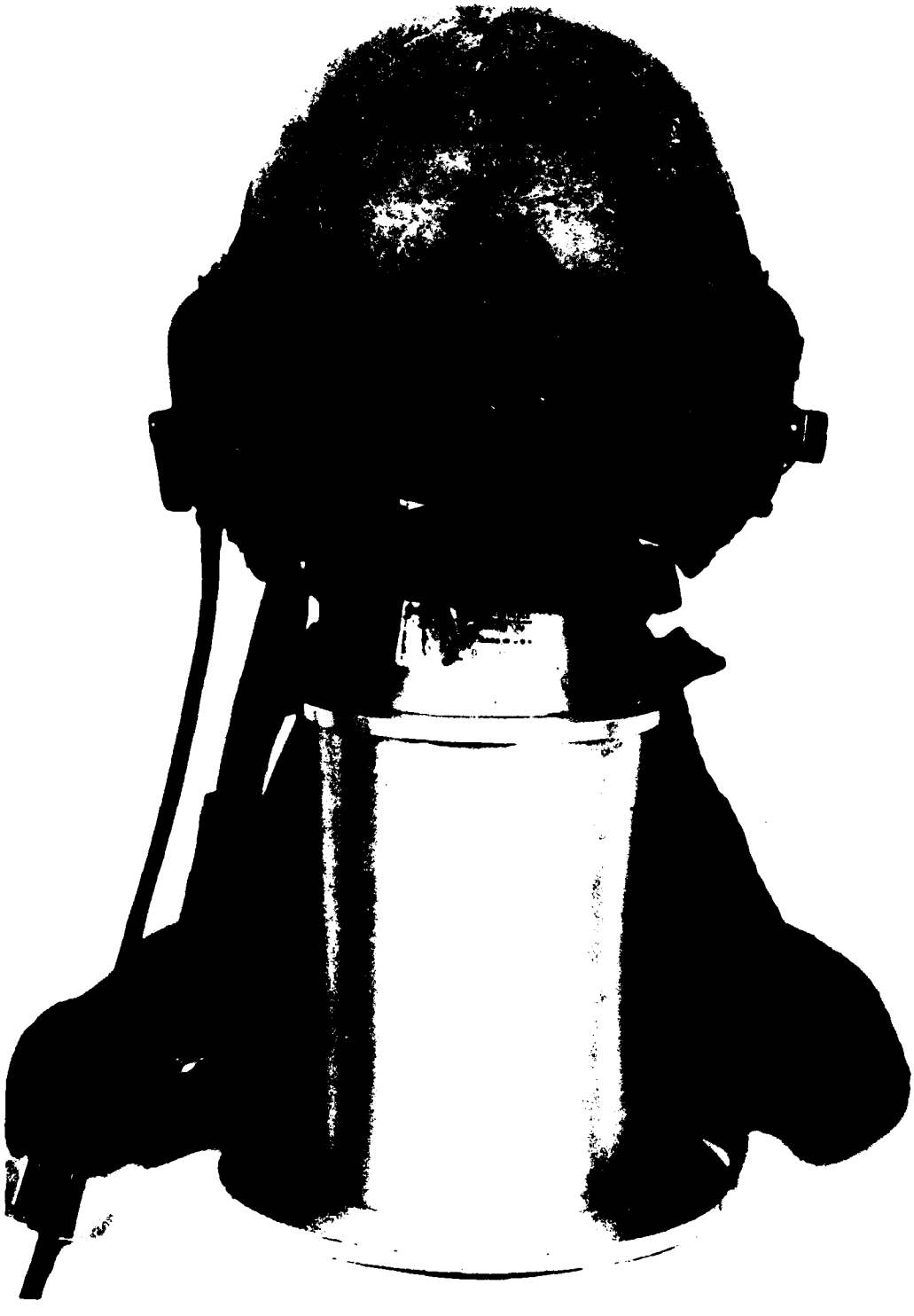


Figure 6D. Rear view of head form with DH 132 CVC Helmet, modified improved CVC goggles, and face mask Concept 2. (NOTE: Location of the face mask's nape strap.